

# Summary of Dodder (*Cuscuta japonica*) Biology, Concerns, and Management

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## General Biology

Dodder (*Cuscuta* spp.) is a yellow-green or orange parasitic vine. While California has many native, sometimes weedy *Cuscuta* spp., *Cuscuta japonica*, or Japanese dodder, is a recently introduced invasive plant. Japanese dodder is native to Asia and is sometimes known as Giant Asian dodder (not to be confused with *Cuscuta reflexa*, commonly called Giant dodder).

Like most dodders, Japanese dodder has a broad host range, including woody and herbaceous plants, commercial crops, ornamentals, and wild plants. Plants that may be resistant to dodder include grasses and some other monocots, as well as shrubs and trees with especially thick bark. However, it is unknown whether monocots are resistant to Japanese dodder, and most infestations in California have occurred on trees and shrubs. Therefore, all plants should be regarded as potential hosts until research is conducted.

Japanese dodder has deltoid, scale-like remnant leaves about 2 mm long. It flowers from August – October with numerous pale yellow to cream-colored flowers that are either sessile or nearly sessile in short, dense, axillary spikes. Each dodder plant produces thousands of hard seeds measuring 2-3mm in diameter. Seed longevity measures 10-20 years in the soil and 50 years or more in dry storage. Germination may occur in the soil at from depths of ½ to four inches or directly on a host.

Seeds disperse by falling from the plant, being carried by water, as contaminants in commercial seed shipments entering the United States, and by various means of human transport. Bird and mammal seed dispersal is unknown. Japanese dodder also reproduces vegetatively: any piece of stem is capable of attaching to a new host and generating a new infestation. Seeds have so far not been found on Japanese dodder in California, making vegetative propagules the most likely means of dispersal.

Seedlings form a thin twining stem that rotates until it contacts a potential host. If contact with a host is not made within about 10 days of germination, the seedling dies. If a suitable host is found, the seedling's connection to the soil atrophies and the plant becomes entirely dependent on the host. Dodder produces modified roots called haustoria that penetrate the host's vascular tissue to extract water and nutrients. Once established on a host, Japanese dodder may grow up to six inches per day. As the dodder grows, stems extend to nearby plants and create new infestations.

Based on its native range in China (Taiwan, Hong Kong, Manchuria), Japan, Korea, and Russia (Amur and E. Siberia), Japanese dodder is hardy in temperate to warm temperate climates. It is said to occur in lowlands and low mountains. In the U.S. heavy infestations of Japanese dodder have been found on ornamental urban vegetation in Florida, South Carolina and Texas.

Japanese dodder is reputed to be hardy to 9 °F; however, this has not been tested or confirmed. Although typically considered an annual, in mild climates such as California, haustoria may

overwinter and regenerate the following spring, making it a facultative perennial (Dr. Fred Hrusa, CDFA, pers. comm.).

Official identification to species is dependant on obtaining flowers: defining characteristics include 1) single style, 2) style as long or longer than the ovary, 3) stigma capitate and, 4) stamens sessile, attached at the corolla sinus. Field biologists in California identify mature, healthy Japanese dodder plants by the spaghetti-like size of the stems, which differs from the thread-like stems typical of native dodder species (F. Hrusa, , pers. comm.). Japanese dodder may also appear more yellow-green in color, especially when stressed, than the orange color typical of native dodders (Ed Finley, CDFA, pers. comm.). Healthy Japanese dodder, however, may also be orange.

### **Distribution**

There are 50 species of dodder in the United States, some native, some introduced. However, all *Cuscuta* spp. are considered to be noxious weeds ( 7CFR part 360 Noxious Weed Regulations (b) Parasitic plants - actually lists 53 *Cuscuta* that are NOT included in the list of noxious weeds). *C. japonica* is both a federally and California state listed noxious weed, and is therefore regulated under both 7 CFR 360 (as a Federal noxious weed) and 7 CFR 330 (all parasitic plants are considered plant pests).

Dodder is used in Asian herbal medicine where it is known as Tu Si Zi or Tu Zi Zi. The use of dodder as an herbal treatment is not restricted to *C. japonica* and herbal remedies may include other species. Herbal uses include a decoction of the seeds used as a male aphrodisiac, a liver, kidney and digestive tonic, and for “female reproductive problems”, among other things. Young shoots are used to treat “sore eyes”. Most dodder infestations appear to be associated with Asian immigrant communities. It is probable that seed or pieces of plant material are being purposefully propagated for medicinal uses.

The first collection of *C. japonica* in California, in 2004, is thought to have originated when a homeowner purchased reportedly “sterile” seed at an Asian herbal remedy store and planted them at home for medicinal uses. Some seeds originally reputed to be *C. japonica* were confiscated from the store by Shasta county agricultural commissioner’s inspectors and tested for viability. According to K. Martyn (Shasta Co. CAC), they were able to germinate 100% of the confiscated seeds. However, Dr. Hrusa later examined some of this seed and concluded that they were too small to be *C. japonica*. The actual species was not determined.

Under federal United States Department of Agriculture (USDA) plant import regulations, any imported *Cuscuta* seed must be inviable. Because of the market for medicinal uses of dodder seed, a pathway for introduction of invasive *Cuscuta* was suspected to be imported herbal medicines. Consequently, in 2005 the USDA’s Smuggling and Trade Interdiction and Compliance (SITC) initiated a market survey of imported dodder seed in California in cooperation with CDFA and the County Agricultural Commissioners offices. Since then, about 50% of herbal remedy seeds tested have proven viable. However, none have been specifically confirmed as *C. japonica* seeds.

Dodder plants growing in Texas and California have not, so far, produced seed. Only flowering plants have been found. Dr. Hrusa self-pollinated *C. japonica* plants in the greenhouse, and no seeds were produced, suggesting that either the plant cannot self-pollinate, or that plants introduced in California are inviable. Dr. Hrusa speculated that a variety of dodder specifically chosen or bred for a lack of seed production in order to increase vegetative growth and longevity may have been imported but at the present time it is unknown how the dodder is entering California. Clemson University in South Carolina seems to have plants producing seeds.

### **Potential Threats**

*Agriculture:* Dodder infestations can weaken the host plant, making it susceptible to other pests and diseases, and may eventually kill its host. Dodder is believed to be a vector for various plant pathogens including several “yellowing” viral diseases, and may possibly be a vector for citrus tristeza, citrus stubborn, and huanglongbing (citrus greening disease). Dodder is known as a parasite of various woody and herbaceous crops in Taiwan and Japan, including, but probably not limited to: fruit trees, tomatoes, potatoes, corn, soybeans, eggplant, cucumber, pea, tobacco, and soybean. Dodder can also infect nursery stock.

*Landscaping:* Most of the Japanese dodder known in the U.S. thus far has occurred in residential areas, and the majority of these have been in homeowners’ yards. Japanese dodder creates large, unsightly mats of vegetation on any plant it infects. Since it is not limited to annuals or perennials, it can infest almost anything from ornamental shrubs and trees to home orchards and vegetable gardens. The cost of removing the dodder and infested host plant could be costly in terms of losing investments of time, labor, plants, or even income.

*Native ecosystems:* Dodder can infest California native species such as willows, California live oak, and buckeye, among other species. Japanese dodder also creates a dense tangle of plant material that may impede birds and other wildlife from using the native host plants. This may be of particular concern in California’s few remaining riparian zones, where Japanese dodder has already occurred. Endangered birds such as the Least Bell’s Vireo may be impacted by loss of nesting sites, or the loss of native species may allow other nonnative species to invade.

### **California Dodder Infestations by County**

See Table 1 for listing of all initial Pest and Damage Reports’ (PDRs) submitted for dodder infestations in California through June 2006.

*Shasta:* In June of 2004, a Japanese dodder infestation was found at a residence on Arizona St. in Redding, Shasta County, California. Plant material was submitted with a PDR by the CAC to the CDFA Botany Lab for identification. In the absence of flowers, Dr. Hrusa initially suspected *C. reflexa*. The following year (July 2005), another PDR was filed and plant material with buds was submitted from the same location. Dr. Hrusa identified it as suspected *C. japonica*. In August of 2005, PDR’s were filed for two more residences where several trees were heavily infested. Because fully mature flowers were never obtained, the identification to species was not confirmed. The Redding infestation was not actively removed, but was

monitored by Ed Finley and appeared to senesce over the winter. As of June 2006 no live plants were observed at any location in Shasta County.

*Yuba:* In late August 2005 another heavy dodder infestation was found on Western Ave. in Olivehurst, in Yuba County. Again, biologists suspected *C. reflexa*, but three separate PDR's with various stages of developing plant material, all apparently from the same address, were submitted, including mature flowers. *C. japonica* was confirmed by Dr. Hrusa and a separate *Cuscuta* expert. This infestation was controlled by Yuba County using eradicated pruning (removal of the infected limbs, but not the whole host plant). Since then, in May 2006, another infestation was found on Linda Ave. in Marysville. A PDR was submitted, and although sterile, the sample was identified as *C. japonica* based on morphological characteristics.

*Contra Costa:* Initially, three populations of invasive dodder were found in Contra Costa County. The three PDR's submitted in 2005 and 2006 are shown on Table 1. The first find occurred in Nov. 2005 at San Pablo Ave. and Stanton in the city of San Pablo, and the second and third in June 2006 on El Cerrito Cr. and Wildcat Cr. in the city of El Cerrito. The El Cerrito Creek infestation crosses the border of Alameda County, as well. The San Pablo infestation was controlled using eradicated pruning and host removal; all infected vegetation was moved to a landfill on April 17, 2006. The Wildcat Creek infestation was controlled by removing all infested vegetation, including a whole small tree, on June 29, 2006. Like the other locations, the Contra Costa infestations occurred at or near residences in the vicinity of a large Asian immigrant neighborhoods and markets. However, unlike the other areas, the 2006 Wildcat and El Cerrito Creek infestations infected native riparian vegetation. The creeks also may have acted as a dispersal vector for vegetative material. Areas along the creek, especially downstream, should be monitored in the future. Further infestations have been discovered at a warehouse near Canal St. and on Gonzaga Ave. in Richmond, and in Antioch during July 2006.

*Sacramento:* Two infestations were initially found in Sacramento County, one in the Rio Linda residential neighborhood and another in the Lemon Hill neighborhood, which backs up on a drainage ditch connecting to the Sacramento River. However, after newspaper articles appeared in July 2006, the number of likely infestation sites in the city of Sacramento increased to over 50. PDR's were submitted, and *C. japonica* identified. However, so far no flowers have been available for confirmation of species. Control of these infestations is pending.

*Los Angeles:* Only one incidence of *C. japonica* is known in Los Angeles County, in a handful of patches on the I-405 freeway near the J. Paul Getty Center. Dr. Hrusa identified a sample as Japanese dodder based on morphological characteristics. This represents the first known occurrence of Japanese dodder in southern California.

## **Survey Methods**

Many infestations found so far in California have been spotted accidentally by biologists driving in residential neighborhoods. Because infestations have been highly correlated with Asian immigrant populations, further driving surveys in Asian communities may be an effective search method. Robin Breckridge (CDFA IPC) has pinpointed the Asian census

populations for Sacramento. Air surveys have proven useful for other invasive species in California, such as hydrilla. Because Japanese dodder is brightly colored and visible from a distance, air surveys may be an effective tool for finding infestations. Air patrol surveys could be conducted using fixed-wing airplanes (via Sacramento County Sheriff) or helicopter (via CA State Highway Patrol) to spot large infestations. Remote image sensing and spectral analysis may also be used to locate infestations, since Japanese dodder's unique color is likely to have a distinct spectral signature.

Public information and outreach is also a valuable tool in locating dodder infestations. The Contra Costa County riparian infestation was located after a community creek preservation group read about the dodder infestation in the CAC newsletter. Shasta and Yuba counties have published public information brochures for neighborhood distribution. Sacramento and Contra Costa counties have held press releases for local newspapers that have generated abundant public response. Translation of a public information brochure into several common Asian languages might also prove a useful tool for identifying and controlling infestations. Most infestations so far have been connected to the Hmong, a group or tribe from Laos, which could be specifically educated on the invasive nature of Japanese dodder outside of its native range. With the Hmong community's support, eradication or control of this species in neighborhoods might be more efficient and cost effective for California and its county governments.

The occurrence of Japanese dodder in L.A. County is of special concern. Many southern California counties have large Asian populations, and southern California's climate is expected to favor the establishment and spread of Japanese dodder. This find also suggests that central California may be equally susceptible to infestations. Surveys for Japanese dodder should be conducted statewide in moderate climate zones.

## **Eradication Methods**

Japanese dodder has been introduced and eradicated in the U.S. a handful of times: in San Antonio, TX – 1941, Quincy, FL – 1943, and Houston, TX – 2004 (although Houston has not yet declared the infestation officially eradicated). The Horticultural Gardens at Clemson University in South Carolina have the oldest known existing infestations in the United States. Japanese dodder was apparently introduced there through imported nursery plants in 1971, but was probably not controlled until 1991. All Japanese dodder in the Gardens apparently occurs on kudzu, a common, exotic, highly invasive leguminous vine, and staff at the Gardens had thought that Japanese dodder used only legumes as hosts. The Gardens attempted eradication using a wide variety of methods, but currently still retain two isolated infestations. Unlike the Japanese dodder in California, Clemson seems to have plants that produce seeds, and it is thought that erosion from the eradicated site resulted in a new downstream infestation. Clemson U. continues to control its dodder using herbicide, and is slowly working at eradication over time.

Eradication of dodder, once established, is difficult. Although plant material can be pulled from the host plant, haustoria left embedded in the host tissue can regenerate a new plant. This necessitates removal of the infested host plants, as well as monitoring the area for some time to

check for subsequent seed germination and regeneration. As in most invasive species, a combination of methods should be employed to ensure effective control and eradication. Dodder usually cannot be eliminated in a single year.

The Texas Forest Service recommends use of pre-emergent herbicides, injected herbicides, rogueing (digging infected hosts or dodder seedlings from the soil), post-emergent herbicides, and eradicated pruning, including removal of all host plants within 10 feet of the infested area to create a host and infection-free barrier. USDA recommends a combined strategy including frequent tillage, flaming and herbicide use, removal and burning of host plants, two applications of contact herbicides within 10 days, soil fumigation and pre-emergent treatment.

If new seedlings are found they can be pulled by hand, or if the infestation is recent, the affected host parts can be pruned off to ¼ to 1/8 inch below the attachment point. Freshly removed plants should not be allowed to contact any other potential host species. Removed material is placed in plastic bags, solarized, and disposed of in a manner approved by or under supervision of the county agricultural commissioner's staff. This is fairly effective in the home garden as long as no pieces of stem or haustoria remain. Cultivation around the host plant can also reduce germination.

In the case of very large hosts, especially with large, extensive infestations, an herbicide injection treatment has been used to kill the dodder before the host and dodder were removed. In South Carolina, at Clemson U. Horticultural Gardens, a variety of means were used to kill the infestation. Mechanical removal of the dodder mats was first, followed by Glyphosate and Dacthal application. Herbicide application on the parasite also killed the host. A controlled burn cleared the ground once all vegetation senesced. The site was then fumigated with methyl bromide. The soil surface was also heated using propane torches before pre-emergent herbicides (Vapam and Basamid) were applied to prevent germination of any remaining *C. japonica* seeds in the soil. Periodic, post-treatment monitoring is required to ensure eradication regardless of treatment method.

Japanese dodder represents a new category of weed for California: an exotic parasitic plant that is potentially invasive and damaging to both native and ornamental landscapes. Eradication efforts in California so far appear successful. However, with new infestations found at an increasing rate, better knowledge of chemical control and other eradication methods will be needed.

Table 1: Pest Damage Reports submitted under *Cuscuta* and Q-rated weeds as of June 2006. Note that PDR's do not always exist for all residences or locations within each site where *C. japonica* has been found.

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